NAL PROPOSAL No. 0091

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#### MADANSKY EMULSION EXPOSURE

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July 31, 1970

Professor Leon Madansky W. W. Hansen Laboratories of Physics Stanford University Stanford, California 94305

Dear Leon:

Thanks very much for your letter of July 27th indicating your continuing interest in early experiments at NAL. I can see no problem at all in your running an emulsion experiment. It will be necessary to think a little bit about the location of the exposure and the means of monitoring the flux so that the emulsions are readable. It is not clear to me what is involved in your proposal to look at neutrals from a small target "with some shower detectors we already have used." I should like to know more about your plans for the experiment.

In both cases, it would be a good idea for you to visit NAL early in the fall to discuss the details of the experiments to see if anyone is interested in a collaboration. Why don't you give me a call around mid-September, and we'll arrange a visit at a time when the appropriate people will be available. Thanks very much for your letter.

Warm regards,

Ned

Edwin L. Goldwasser



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Microwave Laboratory High Energy Physics Laboratory Biophysics Laboratory

AREA CODE 415 DAvenport 7-7800

Down Med,

Our group a Hopkus has bein at SPIC for the past mouth on a run so it knows had a chance to unite you as I endecided about Turn on sperments. We have descussed this problem and we attill would like to consider the possibility of preparery on smaller experient and simply looking at newtrats from a small target with some shower detectors we already have used. We have the means to acquire and develop the enulsions. Clanderstand That Dr. Chien a langeling man it you summer study has discussed Her with Tooking, who seems interested, If you feel that this is a resomable set of things to try, we will visit early in the Tall to desint 4 delail of the experiment, that we have in and with the NAL people and atest a collaboration. Let me know at U about adduss. If what I have outlined is facille at this Time Bat wicks

J.E.O. 2

NAL PROPOSAL No. 0091

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# PROPOSAL FOR AN EMULSION EXPERIMENT TO MEASURE THE ENERGY DEPENDENCE OF TOTAL CROSS SECTIONS AND MULTIPLICITIES UP TO 500 GeV/c

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National Accelerator Laboratory

October 14, 1970

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July 14, 1971

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#### ABSTRACT

We propose to expose nuclear emulsion stacks to unseparated proton and  $\pi^-$  beams at different incident energies between 100 and 500 GeV/c at NAL as soon as the machine is turned on. We will study energy dependence of total cross sections, charged multiplicities, and anomalous events.

#### I. Motivation

Although hadron interactions with incident energy above 30 GeV remains largely unexplored, some interesting results have been reported. E.g. Czachouska et al.  $^{(1)}$  reported from cosmic ray data  $(\bar{\rm E}_{1ab} \sim 200$  GeV) that a large fraction of coherent  $\pi$  - nuclear reactions is due to the diffraction dissociation of pion into 3 pions. This was confirmed by a recent Alma Ata -Cracow -

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Dubna-Moscow Collaboration  $^{(2)}$  at Serpukhov which also shows that the diffraction dissociation cross section of  $\pi^-$  into  $3\pi$  and  $5\pi$  rises sharply with lab energy from 5 to 200 GeV. Grigorov et al.  $^{(3)}$  reported from satellite data that the total inelastic proton-carbon cross section rises about 20% from 20 to 200 GeV/c. Recently Jones et al.  $^{(4)}$  studied the interactions of cosmic protons  $(70-900\,\mathrm{GeV})$  with hydrogen and carbon nuclei. They reported that the averaged charged multiplicities varies with  $\ln\mathrm{E}_{1\mathrm{ab}}$  or  $\mathrm{E}_{1\mathrm{ab}}^{1/4}$  and the multiplicities at each energy follow a Poisson distribution. While most of these results come from cosmic ray data hence suffers from poor statistics, they do suggest that studies even as simple as total cross sections and multiplicities will be very interesting at NAL energies.

#### II. The Experiment

We propose to do a systematic study on the energy dependence of the cross sections of coherent and incoherent interactions and the charged multiplicities. We plan to expose nuclear emulsion stacks to unseparated proton and  $\pi^-$  beam at different incident energies between 100 and 500 GeV/c at NAL. The results can be checked with the predictions from various dynamic models such as multiperipheral, (5) statistical, (6) hydrodynamical (7) and isobar-pionization (8) models. This is an experiment with passive detectors and minimal beam requirement hence can be done when the NAL machine is first turned on. We also note that because the nuclear emulsion has excellent spatial resolution ( $\sim 0.2\mu$  grain size compared with  $\sim 200\mu$  bubble size for bubble chambers) and short interaction and radiation lengths, it is most suitable for studies of high multiplicities and anomalous events. We expect the

data will be useful for the design of later experiments at NAL.

#### III. "Set up"

From several discussions with A. Maschke it appears to us that the best place for this experiment is the beam transfer enclosures. The major difficulty is to reduce the beam intensity from about  $10^{13}$  per pulse to about  $10^{5}/\mathrm{cm}^2$  favorable to nuclear emulsion. This can be done by using an attenuator for the proton beam and a thinner target for  $\pi^-$  exposures. e.g., for a 200 G eV/c proton exposure, one can place 7 feet of steel at the beginning of the enclosure C, and place the emulsion stack at the downstream end. The 200 G e V/c protons will be selected by the beam transfer system for beam to area II. etc. The detailed procedure certainly has to be worked out with NAL staff when the machine construction is near its completion. Each exposure meeds about 10 pulses. Hence all the exposures can be done in a couple of days.

#### IV. Development and Scanning of the Emulsion Stacks

We plan to process the emulsion stacks at the Naval Research Laboratory. The precision microscopes at JHU and NAL will be more than adequate to scan about 1000 useful events in each exposure.

#### References & Footnotes

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